

§1.1310& §2.1091 - MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm²)	Averaging Time (minutes)
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/		f/1500	30
1500-100,000	/		1.0	30

f = frequency in MHz; * = Plane-wave equivalent power density;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:

Predication of MPE limit at a given distance

$S = PG/4\pi R^2$ = power density (in appropriate units, e.g. mW/cm²);

P = power input to the antenna (in appropriate units, e.g., mW);

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

Calculated Data:**Model: L1563****2.4G Wi-Fi&BLE&BT:**

Mode	Frequency Range (MHz)	Maximum Antenna Gain		Tune-up Conducted Power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
		(dBi)	(numeric)	(dBm)	(mW)			
802.11b	2412-2462	2.19	1.66	25.00	251.19	20	0.0829	1.0
802.11g		2.19	1.66	24.00	100.00	20	0.0330	1.0
802.11n-HT20		2.19	1.66	20.00	79.43	20	0.0262	1.0
802.11n-HT40	2422-2452	2.19	1.66	19.00	316.23	20	0.1044	1.0
BLE(1Mbps)	2402-2480	2.19	1.66	-0.50	0.89	20	0.0003	1.0
BLE(2Mbps)	2402-2480	2.19	1.66	-0.50	0.89	20	0.0003	1.0
BT	2402-2480	2.19	1.66	10.00	10.00	20	0.0033	1.0

GSM:

Mode	Frequency Range (MHz)	Maximum Antenna Gain		Tune-up Conducted Power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
		(dBi)	(numeric)	(dBm)	(mW)			
GPRS 850	824-849	1.46	1.40	27.50	562.34	20	0.1566	0.55
EGPRS 850	824-849	1.46	1.40	19.74	94.19	20	0.0262	0.55
GPRS 1900	1850-1910	2.23	1.67	23.50	223.87	20	0.0744	1.00
EGPRS 1900	1850-1910	2.23	1.67	20.24	105.68	20	0.0351	1.00

Note 1:

GPRS 850: Tune-up maximum output power with 1 slot is 33.50 dBm, 2 slots is 33.00 dBm, 3 slots is 31.50 dBm, 4 slots is 30.50 dBm, so the tune-up time based Ave. power compared to slotted Ave. power is 27.50dBm.

EGPRS 850: Tune-up maximum output power with 1 slot is 27.00 dBm, 2 slots is 25.50 dBm, 3 slots is 24.00 dBm, 4 slots is 22.50 dBm, so the tune-up time based Ave. power compared to slotted Ave. power is 19.74dBm.

GPRS 1900: Tune-up maximum output power with 1 slot is 29.50 dBm, 2 slots is 28.50 dBm, 3 slots is 27.50 dBm, 4 slots is 26.50 dBm, so the tune-up time based Ave. power compared to slotted Ave. power is 23.50 dBm.

EGPRS 1900: Tune-up maximum output power with 1 slot is 26.50 dBm, 2 slots is 25.50 dBm, 3 slots is 24.50 dBm, 4 slots is 22.50 dBm, so the tune-up time based Ave. power compared to slotted Ave. power is 20.24 dBm.

Number of Time slot	1	2	3	4
Duty Cycle	1:8	1:4	1:2.66	1:2
Time based Ave. power compared to slotted Ave. power	-9 dB	-6 dB	-4.26 dB	-3 dB

5G Wi-Fi/WCDMA/LTE:

Mode	Frequency Range (MHz)	Antenna Gain		Tune-up Conducted Power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
		(dBi)	(numeric)	(dBm)	(mW)			
802.11a	5150~5250	0.05	1.01	18.50	70.79	20	0.0142	1.0
	5725~5850	0.05	1.01	19.00	79.43	20	0.0160	1.0
802.11ac20	5150~5250	0.05	1.01	21.00	125.89	20	0.0253	1.0
	5725~5850	0.05	1.01	22.00	158.49	20	0.0318	1.0
802.11n20	5150~5250	0.05	1.01	21.50	141.25	20	0.0284	1.0
	5725~5850	0.05	1.01	22.00	158.49	20	0.0318	1.0
802.11ac40	5150~5250	0.05	1.01	15.50	35.48	20	0.0071	1.0
	5725~5850	0.05	1.01	21.00	125.89	20	0.0253	1.0
802.11n40	5150~5250	0.05	1.01	15.50	35.48	20	0.0071	1.0
	5725~5850	0.05	1.01	22.00	158.49	20	0.0318	1.0
802.11ac80	5150~5250	0.05	1.01	11.00	12.59	20	0.0025	1.0
	5725~5850	0.05	1.01	21.50	141.25	20	0.0284	1.0
WCDMA Band II	1850-1910	2.23	1.67	22.50	177.83	20	0.0591	1.0
WCDMA Band V	824-849	1.46	1.40	22.50	177.83	20	0.0495	0.55
LTE Band 2	1850-1910	2.23	1.67	23.50	223.87	20	0.0744	1.0
LTE Band 4	1710-1755	2.23	1.67	23.00	199.53	20	0.0663	1.0
LTE Band 5	824-849	1.46	1.40	23.00	199.53	20	0.0556	0.55
LTE Band 7	2500-2570	2.03	1.60	22.50	177.83	20	0.0566	1.0
LTE Band 38	2570-2620	2.03	1.60	22.50	177.83	20	0.0566	1.0
LTE Band 40 Lower	2305-2315	2.03	1.60	22.50	177.83	20	0.0566	1.0
LTE Band 40 Upperr	2350-2360	2.03	1.60	22.50	177.83	20	0.0566	1.0
LTE Band 41	2555-2655	2.03	1.60	22.50	177.83	20	0.0566	1.0

Note:

1. For the above tune up power were declared by the manufacturer.
2. Wi-Fi and BT/BLE cannot transmit simultaneously.
3. For 802.11b, 802.11g, 802.11a, the tune-up power is base on SISO mode
For 802.11ac20/n20/n40/ac40/ac80, the tune-up power is base on MIMO mode
4. Wi-Fi & GPRS/WCDMA/LTE or BT/BLE & GPRS/WCDMA/LTE can transmit simultaneously; the worst condition is 2.4G Wi-Fi & GPRS 850 as below:

$$\sum_i \frac{S_i}{S_{Limit,i}} = 0.0829/1.00 + 0.1566/0.55 = 0.3676 < 1.0$$

Conclusion: The device meets MPE at distance 20cm.

Model: L1573**2.4G Wi-Fi&BLE&BT:**

Mode	Frequency Range (MHz)	Maximum Antenna Gain		Tune-up Conducted Power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
		(dBi)	(numeric)	(dBm)	(mW)			
802.11b	2412-2462	0.66	1.16	25.00	316.23	20	0.0730	1.0
802.11g		0.66	1.16	24.00	251.19	20	0.0580	1.0
802.11n-HT20		0.66	1.16	20.00	100.00	20	0.0231	1.0
802.11n-HT40	2422-2452	0.66	1.16	19.00	79.43	20	0.0183	1.0
BLE(1Mbps)	2402-2480	0.19	1.04	-0.50	0.89	20	0.0002	1.0
BLE(2Mbps)	2402-2480	0.19	1.04	-0.50	0.89	20	0.0002	1.0
BT	2402-2480	0.19	1.04	10.00	10.00	20	0.0021	1.0

GSM:

Mode	Frequency Range (MHz)	Maximum Antenna Gain		Tune-up Conducted Power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
		(dBi)	(numeric)	(dBm)	(mW)			
GPRS 850	824-849	1.24	1.33	27.50	562.34	20	0.1488	0.55
EGPRS 850	824-849	1.24	1.33	19.74	94.19	20	0.0249	0.55
GPRS 1900	1850-1910	1.22	1.32	23.50	223.87	20	0.0588	1.00
EGPRS 1900	1850-1910	1.22	1.32	20.24	105.68	20	0.0277	1.00

Note 1:

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EGPRS 850: Tune-up maximum output power with 1 slot is 27.00 dBm, 2 slots is 25.50 dBm, 3 slots is 24.00 dBm, 4 slots is 22.50 dBm, so the tune-up time based Ave. power compared to slotted Ave. power is 19.74dBm.

GPRS 1900: Tune-up maximum output power with 1 slot is 29.50 dBm, 2 slots is 28.50 dBm, 3 slots is 27.50 dBm, 4 slots is 26.50 dBm, so the tune-up time based Ave. power compared to slotted Ave. power is 23.50 dBm.

EGPRS 1900: Tune-up maximum output power with 1 slot is 26.50 dBm, 2 slots is 25.50 dBm, 3 slots is 24.50 dBm, 4 slots is 22.50 dBm, so the tune-up time based Ave. power compared to slotted Ave. power is 20.24 dBm.

Number of Time slot	1	2	3	4
Duty Cycle	1:8	1:4	1:2.66	1:2
Time based Ave. power compared to slotted Ave. power	-9 dB	-6 dB	-4.26 dB	-3 dB

5G Wi-Fi/WCDMA/LTE:

Mode	Frequency Range (MHz)	Antenna Gain		Tune-up Conducted Power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
		(dBi)	(numeric)	(dBm)	(mW)			
802.11a	5150~5250	1.57	1.44	18.50	70.79	20	0.0203	1.0
	5725~5850	-0.79	0.83	19.00	79.43	20	0.0131	1.0
802.11ac20	5150~5250	1.57	1.44	21.00	125.89	20	0.0361	1.0
	5725~5850	-0.79	0.83	22.00	158.49	20	0.0262	1.0
802.11n20	5150~5250	1.57	1.44	21.50	141.25	20	0.0405	1.0
	5725~5850	-0.79	0.83	22.00	158.49	20	0.0262	1.0
802.11ac40	5150~5250	1.57	1.44	15.50	35.48	20	0.0102	1.0
	5725~5850	-0.79	0.83	21.00	125.89	20	0.0208	1.0
802.11n40	5150~5250	1.57	1.44	15.50	35.48	20	0.0102	1.0
	5725~5850	-0.79	0.83	22.00	158.49	20	0.0262	1.0
802.11ac80	5150~5250	1.57	1.44	11.00	12.59	20	0.0036	1.0
	5725~5850	-0.79	0.83	21.50	141.25	20	0.0233	1.0
WCDMA Band II	1850-1910	1.22	1.32	22.50	177.83	20	0.0467	1.0
WCDMA Band V	824-849	1.24	1.33	22.50	177.83	20	0.0470	0.55
LTE Band 2	1850-1910	1.22	1.32	23.50	223.87	20	0.0588	1.0
LTE Band 4	1710-1755	2.19	1.66	23.00	199.53	20	0.0659	1.0
LTE Band 5	824-849	1.24	1.33	23.00	199.53	20	0.0528	0.55
LTE Band 7	2500-2570	2.17	1.65	22.50	177.83	20	0.0584	1.0
LTE Band 38	2570-2620	1.47	1.40	22.50	177.83	20	0.0495	1.0
LTE Band 40 Lower	2305-2315	2.06	1.61	22.50	177.83	20	0.0570	1.0
LTE Band 40 Upperr	2350-2360	2.49	1.77	22.50	177.83	20	0.0626	1.0
LTE Band 41	2555-2655	1.47	1.40	22.50	177.83	20	0.0495	1.0

Note:

1. For the above tune up power were declared by the manufacturer.
2. Wi-Fi and BT/BLE cannot transmit simultaneously.
3. For 802.11b, 802.11g, 802.11a, the tune-up power is base on SISO mode
For 802.11ac20/n20/n40/ac40/ac80, the tune-up power is base on MIMO mode
4. Wi-Fi & GPRS/WCDMA/LTE or BT/BLE & GPRS/WCDMA/LTE can transmit simultaneously; the worst condition is 2.4G Wi-Fi & GPRS 850 as below:

$$\sum_i \frac{S_i}{S_{Limit,i}} = 0.0730/1.00 + 0.1488/0.55 = 0.3436 < 1.0$$

Conclusion: The device meets MPE at distance 20cm.